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HANDBOOK ON SEED TESTING

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OBJECTIVE

Were all seeds passing in commerce of good quality and correctly labeled, there would be little, if any, need for the modern seed testing and control station. Conversely, it becomes the chief function of the modern seed testing and control station to determine the agronomic value of seeds which for any reason are of medium or poor quality. It, of course, is necessary to test all grades of seeds good and poor but the important service is in truthfully evaluating those seeds which are diseased or old or damaged or contain excessive amounts of inert material or weed seeds or noxious weed seeds or are adulterated or falsely labeled as to kind or variety or region of growth. In short to protect agriculture from unwittingly using seeds of poor quality is the objective of modern seed testing.

HISTORICAL DEVELOPMENT

Europe - The credit for initiating modern seed testing should perhaps be divided between Möller-Holst of Denmark and Nobbe of Germany. Möller-Holst was the first to point out the importance of seed testing to agriculture and Nobbe was the first to put it into practice at Tharand in 1869. Seed Control Stations soon followed in other European countries. In Denmark, Germany, England and Switzerland beginnings were made under private or association support while in other countries seed testing received government support from the first.

The idea of seed testing spread rapidly and many small agricultural experiment and control stations made seed testing a principal or major line of work. In Bulletin 112 revised, Office of Experiment Stations, U. S. Department of Agriculture, issued in 1904, 132 stations were listed as carrying on seed testing. Since that time there has been a gradual change from many small seed control stations to fewer centralized stations in each country. The present larger stations are more adequately financed than were the smaller ones and so are better equipped both as to facilities and personnel.

North America - The development of seed testing and seed control in the United States and Canada is well outlined in papers presented before the Association of Official Seed Analysts of North America.

SERVICE

Seed Testing for Farmers - The direct service seed testing renders to farmers and the effective enforcement of State laws regulating the sale of agricultural seeds are most important contributions to better agriculture. It is essential that there be at all times a place where any farmer can send the seed he is about to plant and receive accurate information as to its possible plant-producing power as well as its potential weed-infecting danger. In those States where the State seed laws are effectively enforced, there is relatively little need for the individual farmer to send his seeds to be tested except where he buys from another State. In this case he is not protected by the State law, no matter how well it may be enforced, and his only protection is through having his seeds tested by his State seed testing station. Under the present set-up of Federal and State laws covering the trade in agricultural seeds, it is in general poor practice for the farmer to buy

his seeds direct from a seedsman in another State. While the Federal Seed Act prohibits the shipment in interstate commerce of seeds which are fraudulently misbranded, misbranding is not disclosed in the case of out-of-State purchases unless the farmer-buyer sends his seed to his State seed testing laboratory for test.

Seed Testing for the Trade - Another important function of the State seed testing laboratory is testing seeds for the trade. While it does not seem practical for a State laboratory to undertake routine seed testing for the seed trade even on a fee basis, it is important that there be a place in each State or region where the trade may refer samples of seed for test whenever there is doubt or disagreement as to quality. The State seed laboratory is the arbiter of quality in connection with the enforcement of State seed laws, and should stand ready to offer to the trade the same technical assistance that is the basis of law enforcement.

SEED CONTROL

Two general types of seed control have been developed in Europe, both voluntary, in the one case designed primarily to facilitate trade between merchants and in the other to furnish information also to the ultimate consumer.

The Swiss system is based on contracts between the Seed Control Station and seedsmen providing for analyses and certificates based on samples submitted by seedsmen for test. The contract provides the basis for settlement in cases where the seed delivered does not meet the quality indicated by the certificate.

The Danish system provides for sampling and sealing sacks by officials and later labeling with the analysis found.

Various modifications and combinations of these two systems have been adopted by various European countries. Great Britain, through its Seed Control Station at Cambridge, maintains a school for commercial analysts and licenses them after completion of a course of study and a satisfactory examination.

The effect of these systems of seed control on the quality of agricultural seeds delivered to the farmer would seem to vary greatly, with the least benefit from the system designed primarily to facilitate trade between merchants.

REGULATION

International - Sweden was the first country to require the coloring of imported seeds to protect their farmers from being sold unadapted southern-grown seeds as those of domestic growth. A coloring requirement has now been adopted in many countries for specific kinds of seeds. Some countries have specific restrictions on the importation of seeds aside or independent of coloring. These largely refer to freedom from certain weed seeds such as dodder. France, however, requires a certificate as to germination.

Canada and the United States are the two countries having the most rigid import requirements as to quality.

Interstate - The interstate trade in agricultural seeds may be divided into several classes:

(a) Shipment of uncleaned seed from farmer growers to seed dealers for purpose of recleaning.

(b) Shipment of seed from dealer to dealer usually accompanied by labels or information for labels as required by the state into which shipped.

(c) Seed shipped direct to farmers for planting.

(d) Seed, usually of poor quality, trucked across state lines, by persons without financial reliability and sold either to retail dealers or more often directly to farmers.

It is obvious that the opportunity for the farmer to market his crop must be left open to him and that seed going to seed cleaning houses must be conditioned and labeled before being sold in the receiving state.

With the seed shipped interstate from dealer to dealer the only restriction is under the Federal Seed Act which prohibits such sale or shipment when the seed is fraudulently misbranded. This legislation was intended to protect the states from interstate shipment into them of seed which was misbranded and over which the state has no control. The Federal Department of Agriculture makes no initial inspection under this Act, but acts only on reference by the states. The two forms of interstate trade that are most difficult to control are the shipment direct to farmers by mail order houses and the trade by truck. In both of these cases, inspection is difficult or impossible with relatively little control, leaving the way open for frequent fraud and deception.

Intrastate - The farmer who buys his seed in his own state has the protection of his state seed law and generally will get seed better adapted to his conditions than the farmer who buys out of state. There are, however, many crops which may be adapted to a region as crops but seed of which must be grown in other regions on account of diseases, insect pests or natural soil or climatic conditions.

Labeling - The labeling requirements of state laws are not uniform, but most of the essential statements required by the various states can be put on the form label devised by the Association of Commissioners of Agriculture. The most indefinite label statements are those concerning hard seed and weed seeds. The only satisfactory statement of hard seed content is to give the percentage of seeds actually germinated and the percentage of hard seeds separately. Some confusion arises from the fact that the relative percentages of hard seed and those germinated are influenced by the conditions under which the germination test is carried on. With certain seeds, such as alfalfa and hairy vetch, there is a gradual germination of hard seed in contrast with red and sweet clover, where there is a sharp distinction between hard seed and seed that germinates readily.

In the labeling as to weed seed content, the question as to how much seed should be examined as the basis for the label statement is discussed under another heading. In labeling for interstate shipment, it is expected that the label will meet the requirements of the state into which the seed is shipped.

Grades - The Canadian Seeds Act is the best example of a law providing for grades instead of labeling. This system as contrasted with a

labeling law has advantages from the standpoint of the seed merchant but does not furnish detailed information essential to the man planting the seed.

INTERNATIONAL TRADE

There is a large volume of international trade in agricultural, vegetable, forest and horticultural seeds. The efforts at regulation of international trade have been in the direction of control of quality and origin of agricultural seeds, and quarantine of forest seeds. Sweden was the first country to stain imported seeds to permanently mark them to indicate foreign origin. Some form of coloring has later been adopted by many countries for the same purpose. We in North America are most interested in the coloring requirements of the Canadian Seeds Act and the Federal Seed Act. The provisions in the latter Act requiring the coloring of imported seed of alfalfa and red clover became a law at a time when there was a differential in price of $4000 or more a car between European and domestic red clover seed. The results of the many comparative tests of home grown vs. imported seed which have been carried on for years in many countries may have reflected a patriotic interest in home production but the uniformity of results can but indicate the general superiority of home grown seed. There are so many factors involved in the moving of seed from one locality to another, including soil, climate and length of day that it is impossible to predict the performance in the new environment without actual cultural trial.

INTERNATIONAL SEED TESTING ASSOCIATION

The International Seed Testing Association grew out of the European Seed Testing Association. The initial object of the Association was uni-

formity of tests in the various countries to facilitate international trade in seeds. The methods of testing for purity and of evaluating germination tests were, however, such as to favor the merchant selling without due consideration of the planting value of the seed. There has been a gradual change of point of view toward the American procedure to the end that the result of a seed test should show the power of the seed to produce normal seedlings under favorable conditions. When the international trade is firmly fixed on this basis, and not until then, will the International Seed Testing Association render a real service to the international trade in seeds. A form of certificate has been designed furnishing a uniform type of report which should become the basis of international trade and be accepted at its face value in all countries which participate in the Association's activities.

ORIGIN

How determined - The determination of origin is one of the important services seed testing renders to agriculture. It is a difficult determination to make as it must be based largely on the incidental seeds occurring in the crop seeds and presupposes a knowledge of the incidental seeds occurring in the various regions from which seed enters into international or national trade. On account of the gradual spread from region to region and country to country of the incidental seeds through the movement of crop seeds, the determination of origin constantly becomes more difficult and less reliable. The work of Hillman, Volkart and Gentner has given the analyst definite information of the greatest value in making these determinations.

(Table showing the sum of knowledge of incidental seeds by countries).

Verification - A concise statement of the advantages and disadvantages of verification of origin, as developed by the Bureau of Agricultural Economics, of the United States Department of Agriculture, should be given.

IDENTIFICATION

Generic and Specific - Identification of seeds involves a knowledge of the systematic relation of the plants as well as the external and internal morphology of the seeds, seedling characters and other special aids such as fluorescence.

Varietal determination - The positive identity of variety of cultivated plants is most difficult to establish from seed characters. Negative identity is, however, often obvious or easily established and serves both the purpose of the man planting the seed and as a basis for law enforcement.

CERTIFICATION

State Supervision -

Field Inspection -

Testing -

Sealing -

HARVESTING AND CURING

Climate - Details of the effect of climate on seed quality and reasons for regional productivity.

Cleaning - Details of special cleaning processes.

SEED STORAGE

Effect on vitality of storage conditions, temperature, moisture, containers. The literature of grain and seed handling furnishes a definite basis for proper storage.

DORMANCY

The occurrence of the various types of dormancy should be described together with a summary of existing knowledge of treatments that are effective in bringing about the germination of dormant seeds.

BURIED SEEDS

The work of Beale, Duval and Goss furnish the basis of our knowledge of the survival of seeds when buried in the ground for long periods.

SEED-BORNE DISEASES

This is a subject which has been given too scant attention by the seed analyst and one which is of vital importance. In Europe the Holland Seed Control Station has been the leader in this work.

THE ANALYST

A broad knowledge is required if the seed analyst is to render the service which is due the man who puts seed in the ground to raise a crop. It includes all branches of plant knowledge.

(a) Systematic botany - herbarium material, both seed and plants, identification

(b) Plant morphology - structure of seeds

(c) Plant physiology - factors involved in germination

(d) Plant pathology - seed-borne diseases

CLASSES OF SEEDS

All classes of seeds are involved, as all kinds of cultivated plants which are propagated by seeds can only be produced to advantage with seeds of known quality. Weed seeds no matter where they occur or whether they are innocuous, noxious, or potentially noxious are a necessary field for study by the analyst.

SAMPLING

The principles involved and directions for sampling are well set out in the draft of "Rules for Seed Testing" and the comments accompanying them. Methods and types of mechanical aids should be described and illustrated.

ANALYSES

There are certain inconsistencies in method of analysis as now practiced. Our own rules have accepted the "Continental" method for grasses and the "Irish" method for other seeds while the "International Rules" accept the "Continental" method for grasses and provide both "Irish" or "Quick Method" and the "Continental" or "Stronger Method" for other seeds. The direct method as outlined by Miss Musil has real merit and may well come into general use.

WEEDS

Weeds, both noxious and useful, should be studied to know their relative effect with the knowledge that as the interchange of seeds progresses on a world basis that all weeds distributed in seeds tend towards world-wide distribution as far as climatic and soil conditions permit. It cannot be expected that any form of border inspection will keep any area free from the introduction of any weed with commerce in seeds passing across such border.

ADULTERATION AND ADULTERANTS

While wilful adulteration is largely a thing of the past the principal adulterants which have appeared should be described for the various crop seeds. It is fortunate that the age - still vivid in the memory of some analysts - has passed when the United States imported

from Europe bur clover seed reclaimed from South American wool for no other purpose than to adulterate seed of alfalfa and red clover, and colored sand was used for the same purpose.

MIXTURES

Formulas for mixtures which have been found adapted for various regions and for definite purposes may be given. In general, however, the purchase of mixtures should be discouraged as they lead to deception and cannot be economically tested.

EXAMINATIONS

Unnecessary work should not be put on the analyst. For many purposes the information wanted may be obtained through an examination, an approximation or some special test without involving the time required for a complete test. It is easier for the person wanting the information to ask for a complete test than to be specific but it places an unnecessary burden on the ever overworked analyst.

VITALITY

When does a seed die? It is known that seeds given sufficient dosages of x-rays will germinate and start growth but stop growth at a definite stage. Following such treatment the early stages of germination appear normal but the seeds are incapable of producing plants. Seeds which are losing their vitality are in much the same condition as x-rayed seeds as many seeds will go through the early stages of germination but are not capable of continued growth. It must ever be kept in mind that the seed analyst is under obligation to properly evaluate the quality of poor seed. In a lot of seed which is losing vitality all grades of deadness are present, from those seeds which have

lost none of their potential vigor to those which are weak and others which are completely dead. In the animal world there is health and weakness and death which latter is a definite thing, while with plants there is no sharp physiological line between weakness and death. The analyst must draw an arbitrary line on one side of which he considers all seeds of no value and on the other side those capable of producing plants.

The alternative to making this distinction is what has been the custom in some countries i.e. to give a high germination value based on the initial stages of germination followed by qualifying statements quite at variance with the percentage statement given. Aside from the fact that this form of statement misleads the man who plants the seed to grow a crop, it is obvious that it is of little value in law enforcement. It cannot be too often repeated that the obligation of the analyst with respect to germination is to determine what proportion of a given lot is capable of producing plants under favorable conditions.

Laboratory Tests - Here should be given definite descriptions of the varying methods of testing seeds for germination both here and abroad with their relative usefulness in evaluating normal seedlings including special treatments where necessary.

Soil Tests - The expression soil test has been used in various senses to include tests in soil boxes in incubators, in soil in the greenhouse and in the open ground. Tests in soil boxes in incubators in which a saturated atmosphere is maintained cannot be looked upon in the same sense as a soil test made in the greenhouse as it is practically impossible for a normal seedling to develop under the chamber conditions. These tests are,

however, of great value to the experienced analyst as they furnish an accurate indication of what the seed will do in the greenhouse. The greenhouse test must be looked upon as the standard for here under favorable conditions it is that the seedling will show its ability to establish itself. The chief difficulty with testing in the greenhouse is that in most places the summer temperatures are so high that work has to be discontinued for several months each year. With the present advances in air-conditioning its successful and economic application to greenhouse control is no doubt near. When this time arrives the difficulties incident to making germination tests will be largely removed. Until that time it will be necessary to continue making tests under the more artificial conditions and checking them in the greenhouse so often that the analyst is able to properly interpret the laboratory tests.

Testing in the field is impracticable from the standpoint of determining the plant producing power of the seed on account of the adverse conditions of soil and weather.

Soil Sterilization - There seems to be no necessity of sterilizing soil when it is known to be free from damping-off fungi. If unsterilized soil is used the most careful watch must be kept to discover the appearance of damping-off fungi as tests cannot be relied on once it has appeared. Some soils become toxic when sterilized with live steam and all those containing organic matter are made more subject to the growth of fungi and bacteria. The electric sterilization at low temperature developed in New York seems to largely obviate both difficulties. With this type of electric sterilizer described a small amount of soil in the bottom remains unsterilized.

Evaluating Tests - The evaluation of tests is well treated in the "Rules and Recommendations". It should ever be kept in mind that the proper evaluation of germination tests is in any case dependent on the experienced judgment of the analyst and that rules are only an aid but cannot replace experience. It may be helpful to describe and illustrate the various types of abnormal seedlings. In all cases germinated seeds should not be counted until such time as the analyst is confident the seedlings are capable of continued growth. When for any reason tests are unusually slow it is an indication that the conditions are not right for that particular lot of seed and other tests should be made.

APPARATUS

The various mechanical aids to seed testing should be described and illustrated. In Europe there has been a tendency to develop many types of special apparatus while the North American analysts have used essential though fewer mechanical aids.

Sampling - Of the various devices some are adapted to taking samples from large bulks and others for drawing working samples from the sample submitted for test, while some are adapted to certain kinds of seeds and not to others.

Purity - Among the important aids are some type of blower for removing chaff and light matter, sieves, lenses and binoculars, vacuum counters and a mirror box for examining seed by transmitted light

Vitality - The essential requirements are given in the "Rules and Recommendations". Specific examples of stock articles which have been adapted to use should be given as well as any specially designed equipment.

REPORTS

There are many reasons in favor of issuing a single report to cover all information derived from a single sample, as a statement of live pure seed can then be made. There has no doubt been a tendency to issue separate reports of purity and germination because the percent of purity is relatively fixed while the percent of germination is more variable. It is highly important that the question of identity be made clear. The report should distinctly show the name under which the seed is received and whether an identity determination has been made or not.

Accuracy - This matter has been treated statistically by Collins, Stevens and Leggatt. The fact should not be lost sight of that no percentage or numerical statement is exact and that the degree of accuracy secured must be balanced against the labor necessary to produce it.

Reference Work - Franck's bibliography

Appendix - Tabular matter